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The first discovery of the genus *Narycia* (Lepidoptera, Psychidae) from Japan, with description of a new species

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Abstract. A new species of the family Psychidae *Narycia emikoae* Niitsu, Jinbo & Nasu, **sp. n.** is described from Japan with illustrations of adults and genitalia, biological information, and DNA barcode data. The larvae feed on lichens on rocks. The discovery of the new species might help us to understand the Palaearctic biogeography of psychid moths.

Introduction

The family Psychidae is comprised of nearly 1,350 species globally (Sobczyk 2011). The larvae of these moths usually make their larval cases of dead leaves and small twigs; thus, the members of this family are called bagworm moths. Adult females are usually wingless, but the females of the more primitive lineages have normal wings.

The genus *Narycia* was established by Stephens in 1836 (type species: *Tinea monilifera* Geoffroy, 1785). This genus belongs to the tribe Naricini of the subfamily Narycinae, and includes several species known from the Palaearctic Region (Sauter and Hättenschwiler 1991). Sobczyk (2011) recognized seven species of the genus: *duplicella* (Goeze, 1783) from Central to Northern Europe; *astrella* Herrich-Schäffer, 1851 from Central to Southern Europe; *negligata* Diakonoff, 1955 from Papua New Guinea; *infernalis* Herrmann, 1986 from France; *tarkitavica* Zagulajev, 1993 from Russia; *maschukella* Zagulajev, 1994 from Russia; and *archipica* Zagulajev, 2002 from Russia. Most species from the Oriental and Afrotropical region described as *Narycia* are incorrectly placed in this genus (Sobczyk 2011), and it is unclear whether *N. negligata* truly belongs to the genus. Until now, the genus *Narycia* has not been recorded from Japan.

In 2011, 2013, and 2015, one of us (SN) collected some unknown psychid larval cases at Yunomaru-kougen in Gunma Pref., Honshu, Japan. Through morphological observation of the larval cases we noticed that they were similar to those of the genus *Narycia*. They were reared and emergence of both male and female adults was obtained, both of which have well-developed wings and are capable of flight. Based on examination of the wing venation, genitalia and the foreleg condition of this species, we concluded that it belongs to the genus *Narycia* and is new to science.

In the present paper it is described as a new species, *Narycia emikoae* sp. n., and its biology is described, including the structure of the larval cases.

Materials and methods

The larvae and pupae of the new species described here were collected at the following localities: Yunomaru-kougen, Tsumagoi-mura, Gunma Pref., Honshu, Japan in 2011–2015.

For examination of the wing venation, wing scales were removed in 70% aqueous ethanol, and wings stained with acetocarmine solution. Legs and genitalia were dissected after being macerated in a 10% aqueous solution of potassium hydroxide for about ten hours at room temperature. The legs were stained with acetocarmine solution and the genitalia with chlorazol black E.

Images of adults were obtained using digital cameras. For pictures of adults, multi-focused montage (stacked) images were produced using Helicon 4.75 Pro from a series of source images taken by a Canon EOS Kiss X5 digital camera attached to a Nikon SMZ1270 microscope. In addition, images of legs and genitalia were taken using a Nikon Coolpix 8400 camera attached to a Nikon Eclips E200 microscope. Digital images of adults, genitalia and larval case were enhanced using Adobe Photoshop software.

For DNA analysis, a hind leg was removed from each reared adult (two males). Total DNA was extracted using Qiagen DNAeasy Blood and Tissue Kit and following the manufacturer's instructions. Fragments of the mitochondrial COI gene were amplified following the standard protocol for capturing DNA barcodes. The DNA fragments obtained were sequenced by the Dragon Genomic Center, Takarabio Inc, or using an ABI 3500 Genetic Analyzer. The closest species were searched, based on the DNA barcode sequence obtained, using the identification engine of Barcode of Life Data Systems (BOLD) (Ratnasingham and Hebert 2007) with all barcode records option. Sequences determined in this study are registered in the DNA Data Bank Japan (Accession No. LC160294 and LC160295).

Description

Genus *Narycia* Stephens, 1836

Nom. Br. Insects (2): 118.

Type species. *Tinea monilifera* Geoffroy, 1785 (=*Narycia elegans* Stephens, 1836), by monotypy.

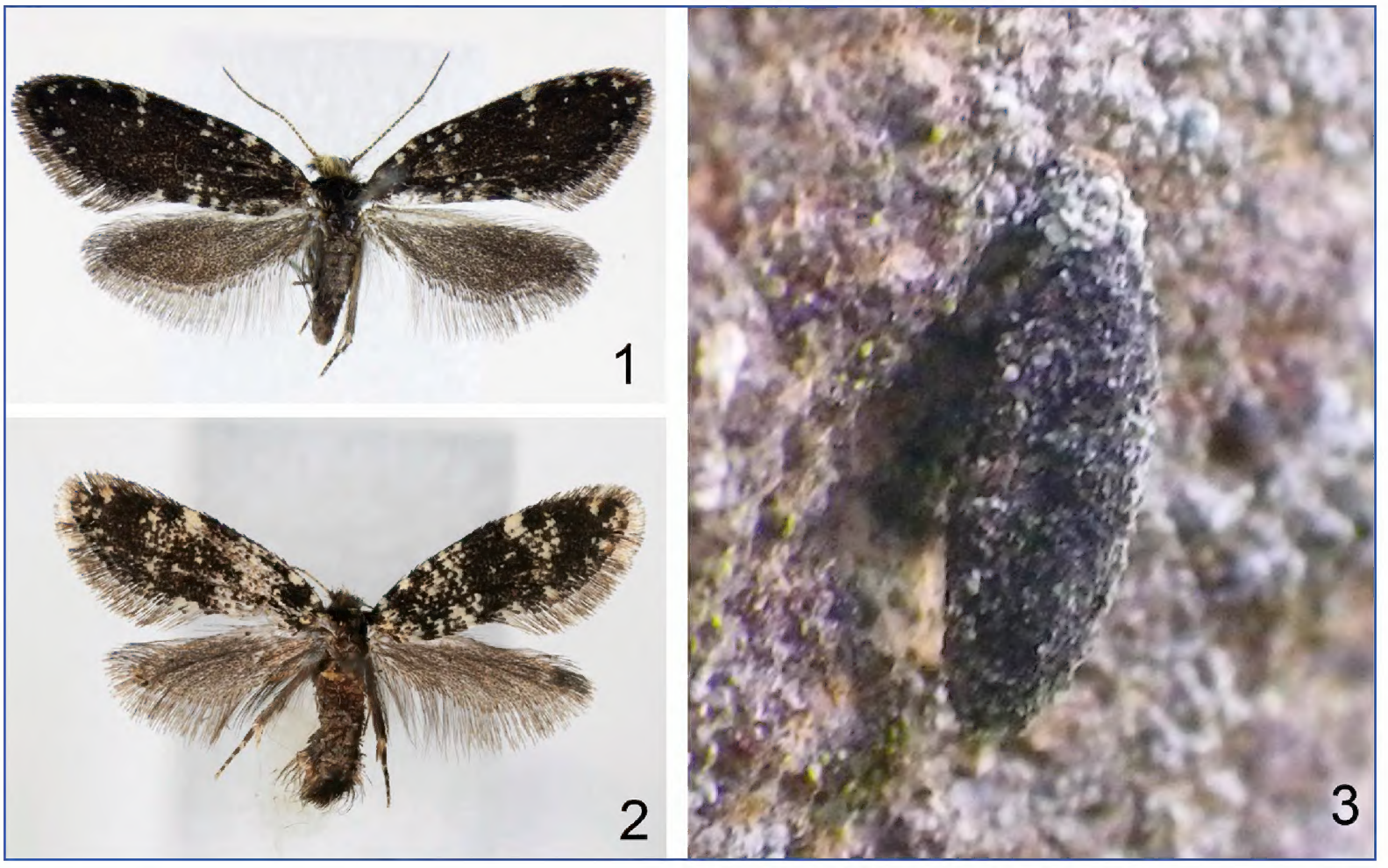
Narycia emikoae Niitsu, Jinbo & Nasu, sp. n.

http://zoobank.org/AD739F56-47BC-4907-BBF7-77C92923BC08

Japanese name: Shimofuri-chibi-minoga

Figs 1–14

Diagnosis. Small-sized blackish-brown moths (wing span 9.0–11.0 mm) with fully developed wings in both sexes. The present new species is closely similar to European *Narycia astrella* on the basis of wing color and pattern, but different from it as follows. The wing span of *emikoae* is much smaller than that of *astrella* (wing span 12–14 mm given by Kozhanchikov 1956). The large



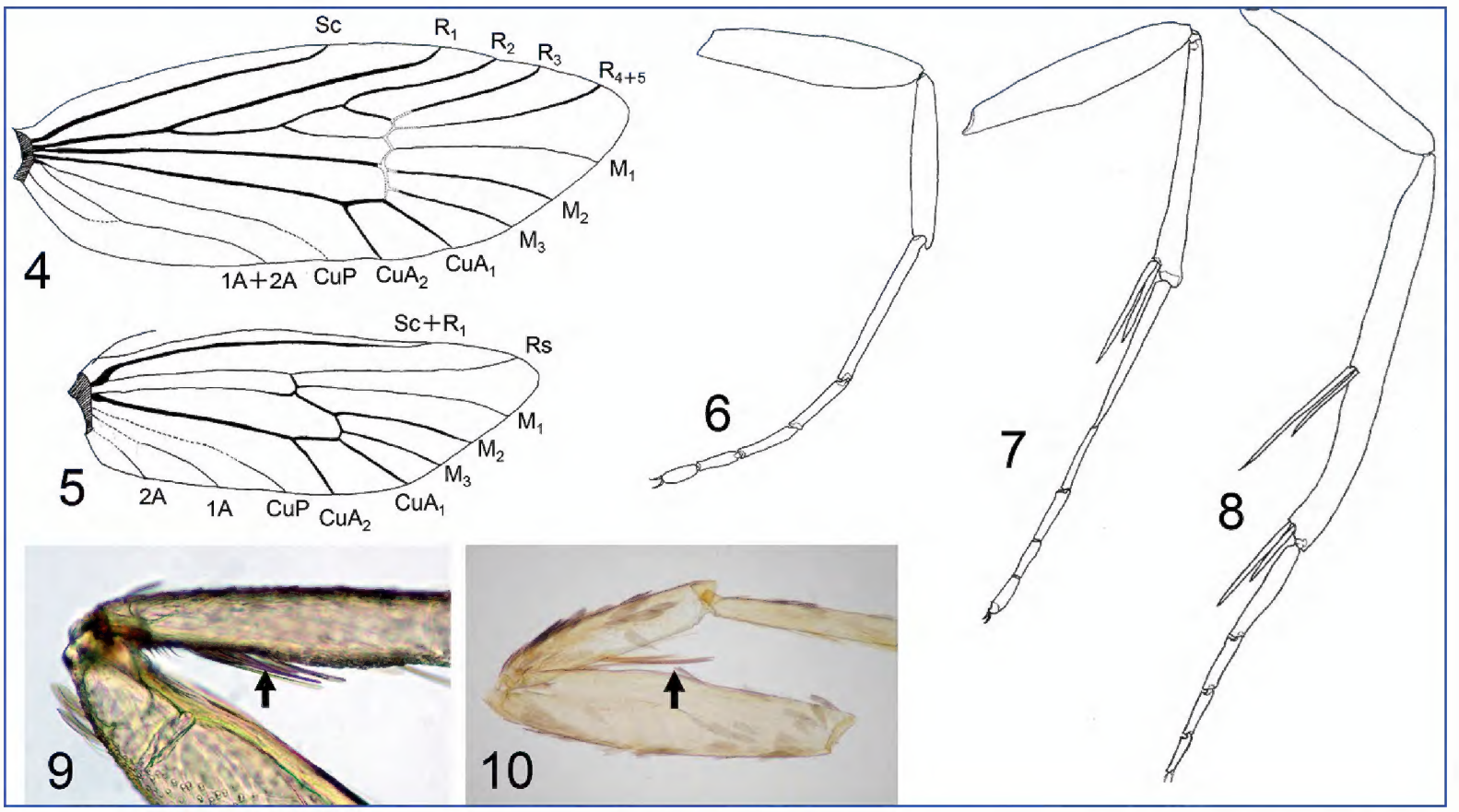
Figures 1–3. *Narycia emikoae* Niitsu, Jinbo & Nasu, sp. n. **1.** Paratype male from Yunomaru. **2.** Paratype female from Yunomaru. **3.** Larval case.

yellowish-white spot at the central costal area of the forewing in the female is much larger than that of *astrella*. It is smaller in size than *astrella* as the ratio of valva and phallus in *emikoae* is 1.0, while that of *astrella* is about 0.6 (Dierl 1972).

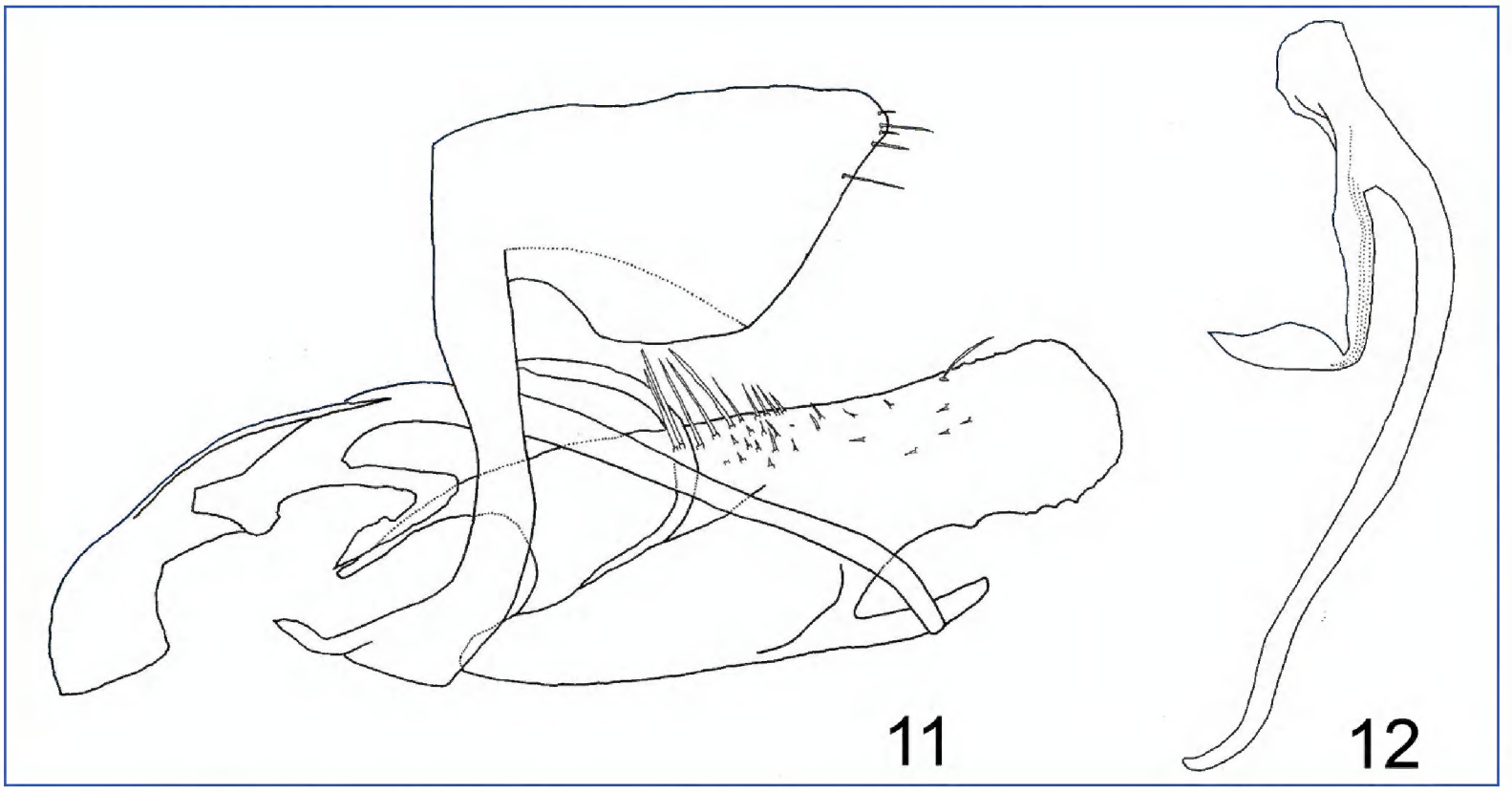
Adult (Figs 1, 2). Head clothed with light greyish-yellow hair-like scales. Antenna simple, greyish-yellow, nearly as long as half-length of forewings. Thorax and tegula blackish brown. This new species shows distinct sexual dimorphism on the point of forewing spot patterns and wing size. Forewing expanse 10.5–11.0 mm in male, and 9.0–11.0 mm in female. Forewing conspicuously triangular, narrow, blackish brown with scattered pale yellowish spots. Costal area with a row of 3–4 small clearly defined spots in both sexes. The large yellowish-white spot at the central costal area of the forewing in the female is much larger than that of male. Forewing cilia of male brown, in contrast that of female striped between greyish-yellow and blackish-brown. Hindwings narrower than forewings. Fore-tibia with a hair tuft (Figs 9–10, arrow), but lacks epiphysis in both sexes. Abdomen covered with fuscous to blackish brown scales.

Venation of wings (Figs 4, 5). Venation typical of *Narycia*. Sc terminating before middle to costa; R_1 from near middle of dicoidal cell; R_4+R_5 fused. Forewings with accessary cell cut off at upper angle of discoidal cell by the stem of R_{4+5}. The R_{4+5} reaches costa. M-stem clearly observed. The media divides the discoidal cell in half. The two branches of the cubitus are short and widely separated. 1A+2A form a short cell in the basal area and are fused in the middle area. Hindwing media simple in discoidal cell; M_1 to termen; M_3 nearer to CuA_1 than M_2; 1A and 2A separate; 3A absent.

Male genitalia (Figs 11, 12). Tegumen slightly long. Uncus rudimentary. Vinculum long and narrow; saccus small. Phallus slender, curved without cornutus, and same length as valva (Fig. 11).



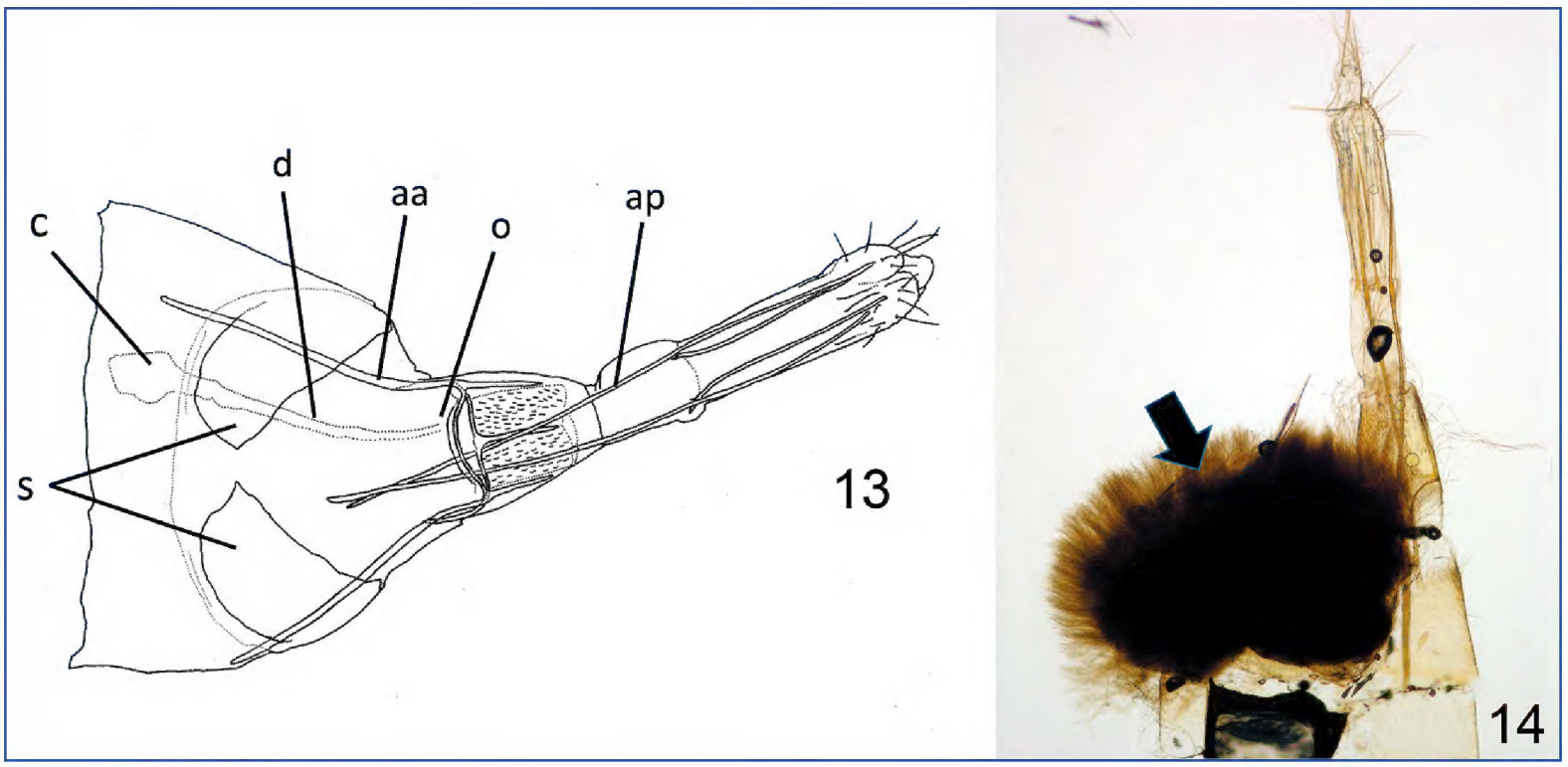
Figures 4–10. *Narycia emikoae* Niitsu, Jinbo & Nasu, sp. n. **4.** Forewing venation. **5.** Hindwing venation. **6.** Female left foreleg. **7.** Female left midleg. **8.** Female left hindleg. **9.** Male left tibia of foreleg, scaled condition. **10.** Female left tibia of foreleg, scaled condition. Black arrows point to the long hair tuft of the fore-tibia in Figs 9–10.



Figures 11–12. *Narycia emikoae* Niitsu, Jinbo & Nasu, sp. n. **11.** Entire male genitalia, lateral view. **12.** Phallus, lateral view.

Valva almost rectangular; costa armed with several setae basally; sacculus sharply protruded, becoming a finger-like process.

Female genitalia (Fig. 13). Papilla analis slender, bearing several long setae.



Figures 13–14. 13. *Narycia emikoae* sp. n. female genitalia, ventral view. (aa, apophysis anterioris; ap, apophysis posterioris; c, corpus bursae; d, ductus bursae; o, ostium bursae; s, sclerotizations of 7th sternite armed with hair tuft). **14.** A pair of large hair tufts on the seventh sternite of the female (black arrow).

Ovipositor long. Apophysis posterioris slender, longer than apophysis anterioris. Ostium bursae opens in a posterior position on segment VIII, but unclear (Fig. 13o). Ductus bursae narrow, weakly sclerotized (Fig. 13d). Corpus bursae small, weakly sclerotized, without signum (Fig. 13c). Seventh sternite with a pair of semi-circular sclerotizations (Fig. 13s), armed with a large hair-tuft (Fig. 14).

Distribution. Japan (Gunma Pref., central Honshu).

DNA barcode. Sequences of DNA barcode region were obtained from two specimens and registered to DDBJ (Accession No. LC160294, 287 bp; LC160295, 648 bp). No difference was found between 287 bp of the two obtained fragments. According to a search using BOLD identification engine, the DNA barcode sequence of the new species is the closest to those of *Narycia duplicella* with 96.53 to 97.25% similarity. The difference between the DNA barcode sequences of two species suggests that the two species should be recognized as distinct species. On the other hand, we cannot compare the new species and *N. astrella* because there is no registered sequence of the latter species in BOLD database.

Type material. Holotype - Male. Yunomaru-kougen, Gunma Pref., Honshu, Japan, 1. vii. 2011 (emerg.), S. Niitsu (Coll. ID NSMT:I-L:30417). Paratypes: 2 males, same locality as the holotype, 25. vi. 2015 (emerg.), S. Niitsu (NSMT:I-L:30420; Accession No. LC160294), 28. vi. 2015 (emerg.), S. Niitsu (NSMT:I-L:30421; Accession No. LC160295); 2 females, same locality as holotype, 22. vi. 2013 (emerg.), E. Niitsu (NSMT:I-L:30418), 27. vi. 2013 (emerg.), E. Niitsu (NSMT:I-L:30419). Types are deposited in the National Museum of Nature and Science, Japan.

Biology. Larvae feed on lichens. The larval case is oval, covered with dark green lichen and sand (Fig. 3). Length of the full-grown larval cases is 5.1–5.5 mm. The larval cases of this species have a triangular cross section and resemble those of related *Narycia* species. They are found on rocks and stone monuments that are covered with bryophytes and lichens. Adults emerge from late June to early July in mountainous areas of central Honshu. Field work has shown that the new species appears to have a two-year life cycle, from egg to adult.

Etymology. The species name is dedicated to Emiko Niitsu, who helped us to collect the bagworm of the new species.

Discussion

The genus *Narycia* is allied to the genus *Paranarychia* Saigusa, 1961, a monotypic genus known from Japan. According to Saigusa (1961), the members of the two genera resemble each other in wing coloration and pattern, with minute spots on wings of both sexes, but *Narycia* can be distinguished from *Paranarychia* by the following characters: 1) the forewings with an accessory cell ending at the upper angle of the discoidal cell by the stem of R_{4+5}, 2) the hindwing media is simple in the discoidal cell, and 3) the fore-tibia has a well-developed epiphysis. Hättenschwiler (1997) regarded the fore-tibia with a well-developed long hair tuft instead of an epiphysis in females as another diagnostic character of *Narycia*.

The new species undoubtedly belongs to the genus *Narycia*. The wing venation, the forewing color patterns and the male genitalia are typical of other *Narycia* species. The result of DNA barcode analysis also supports the inclusion of this species into *Narycia*, though DNA barcode data is available only for one known species *N. duplicella*. However, the new species has one unique character, i.e. the fore-tibia of the new species lack an epiphysis not only in the female, as other member species of *Narycia*, but also in the male. Such foreleg condition, without an epiphysis in the male, is unique to this new species.

The genus *Narycia* is widely distributed throughout the Palaearctic Region. The six known Eurasian *Narycia* species usually inhabit forests, while the new Japanese species mostly inhabits open and arid places such as roadsides. In addition, the species is also found in high altitude mountainous areas of Japan. It is considered that the high altitude areas of central Honshu in Japan function as interglacial refugia in Far East Asia for many organisms of cold regions, including Lepidoptera (Nakatani et al. 2007).

In general, small-sized psychid species feeding on lichens have low migration ability and speciation might occur in various places. In fact, the distribution area of each *Narycia* species is restricted in certain areas. Taken together, the new *Narycia* species found from central Honshu in Japan might be a relic from the glacial epoch, and this discovery may help us bring new insight to the biogeography of Palaearctic psychid moths. In future, a phylogenetic and biogeographical study will be required to clarify the systematic position of this species, the evaluation of the unique character of the male fore-tibia with a hair tuft, and the diversification of this genus.

Acknowledgments

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